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Forest Insect and Disease Management

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BIOLOGICAL
EVALUATION R2-76-16

FUSARIUM ROOT DISEASE OF
CONTAINERIZED TREE SEEDLINGS

Colorado State Forest Service
Nursery

SEPTEMBER 1976

Rocky Mountain Region

U.S. Department of Agriculture Forest Service

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INTRODUCTION

During a September 1976 visit to the Colorado State Forest Service greenhouse, numerous dead and dying containerized tree seedlings were observed at several locations. An evaluation of the amount and extent of damage was requested by the nurseryman, Marvin Strachan.

A preliminary diagnosis of Fusarium root disease was made based on signs and symptoms of diseased seedlings. Damage was most acute on Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) but was also severe on pinyon (*Pinus edulis* Engelm.). Scattered instances of this disease were found on other tree species but the principal damage was to the two aforementioned species. To confirm the cause of the damage and determine its incidence, an evaluation of all container-grown Douglas-fir and pinyon seedlings in the greenhouses was conducted.

METHODS AND MATERIALS

Samples of dead and dying seedlings were collected during October 1976 and taken to the Forest Insect and Disease Management laboratory for analysis. Symptoms and signs were recorded during examinations of diseased seedlings. Fresh tissue mounts and fungal cultures were made for symptomatic hypocotyl and root tissues. Macro- and micro-photography were used to document the disease syndrome.

A 100 percent survey of all containerized Douglas-fir and pinyon seedlings was conducted in November 1976. The Douglas-fir seedlings were being grown in two separate greenhouses in styroblock containers, 30 cells per block. Pinyon seedlings were all in the same greenhouse but had been planted in two types of containers; half of the pinyon were in tar paper pots and the remainder were in styroblocks. All seedlings were examined and the number of symptomatic seedlings recorded based on the following disease criteria: chlorotic or reddish foliage, blackened and decayed roots, and the presence of whitish-yellow fungal fruiting stuctures on the seedling hypocotyl.

RESULTS AND DISCUSSION

Disease Diagnosis

Laboratory tests confirmed the preliminary diagnosis of Fusarium root disease. Diseased seedlings exhibited typical erumpent patches of fungal fruiting bodies called sporodochia on the hypocotyl (Figure 1);

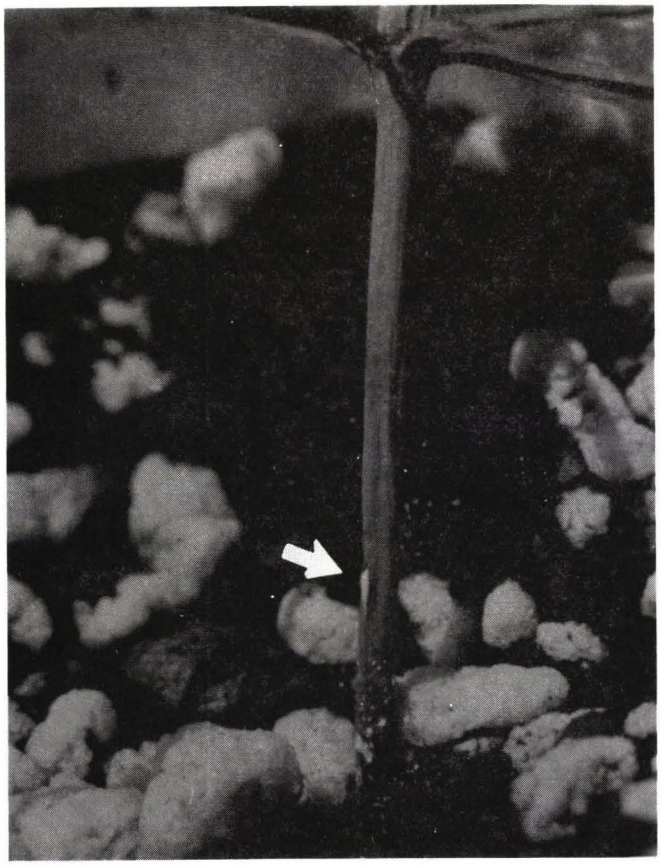

Figure 1 - The Fusarium fungus often forms whitish-yellow sporodochia on the seedling hypocotyl just above ground level.

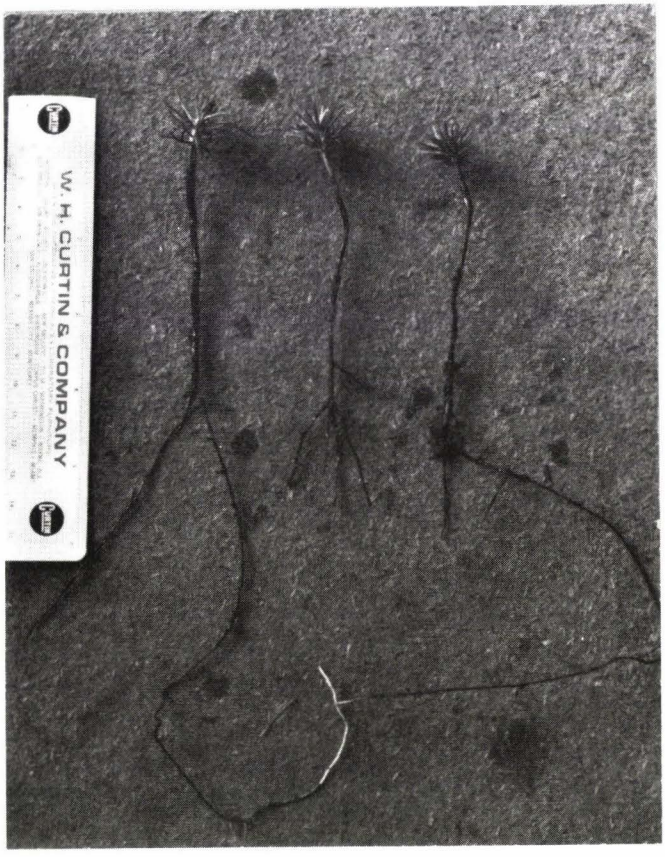

Figure 2 - The main taproot of infected pine is often completely rotted away and resistant seedlings form new lateral roots above a protective callus layer.

typical *Fusarium* spp. macroconidia were readily visible in fresh mounts of this tissue. The cortex of seedling stems and roots had been completely decayed and fungal mycelia were observed in its place. Root systems from diseased trees had completely necrosed in most cases and the epidermis sloughed easily. Resistant seedlings were stunted and formed callus tissue on the main taproot in response to disease progression; new lateral roots often originated at this point (Figure 2). These signs and symptoms are identical to those of Fusarium root disease caused by *F. oxysporum* (Schlect. emend. Synd. & Hans.) (1).

Fungal cultures of diseased seedling tissue were also positive for *Fusarium* spp. The taxonomy of this genus is unsettled at present although several general groups can be identified. Based on the presence of chlamydospores and structure of macroconidia and microconidia, the isolate fungus was tentatively assigned to the *Fusarium oxysporum - F. solani* complex (2). Slant cultures of the fungus were sent to two authorities and the presence of both *F. oxysporum* and *F. solani* was confirmed. (W. Lock and R. Anderson, Pers. Comm).

Fusarium root disease is one of the most common and destructive seedling diseases in the world. The Fusarium fungus is a common soil saprophyte that attacks and kills the roots of a seedling, causing chlorosis, stunting and wilting of the top and eventually death (1). This disease can be spread by special resting spores called chlamydospores in contaminated soil or by airborne conidiospores from the sporodochia on the stem.

Damage Survey

Over 23,000 seedlings were surveyed for Fusarium root disease and almost 8 percent exhibited typical symptoms (Table 1). Actual disease incidence is probably much higher because many seedlings may have been infected but did not exhibit visible symptoms. Many infected conifer seedlings merely remain stunted and fail to achieve merchantable size (Figure 2). Annual losses to this disease in British Columbia nurseries ranged from 2-15 percent (3).

TABLE 1 - *Fusarium* root disease survey of containerized seedlings at the Colorado State Forest Service Nursery.

Tree Species	Location	Total Seedlings Surveyed	Symptomatic Seedlings No.	Symptomatic Seedlings %
Douglas-fir	Old Greenhouse	9630	347	3.6
Douglas-fir	New Greenhouse	6690	942	14.2
Sub Total		16,320	1289	7.9
Pinyon	New Greenhouse Tar Pots	4650	479	10.3
Pinyon	New Greenhouse Styroblocks	2460	86	3.5
Sub Total		7,110	565	7.9
	Totals	23,430	1,854	7.9

Douglas-fir seedlings suffered losses ranging from under 4 to over 14 percent depending on the greenhouse in which they were housed (Table 1). The higher damage in the newer facility is difficult to explain. Environmental factors and cultural techniques were similar to both houses and the seed source was identical. One observable difference was the presence of discarded tree seedlings from previous thinnings on the floor of the newer facility. This could be significant because Fusarium is an aggressive saprophyte and may have built up to pathogenic levels in this refuse. Fungal spores generated in this infected litter could have been aerially disseminated to the containerized seedlings. This immediate source of inoculum could explain the difference in damage between the two greenhouses.

Pinyon losses to Fusarium root disease varied from 3.5 percent in the styroblock type of container to 10.3 percent in the tar pot seedling container (Table 1). The greater losses in the tar pot containers may be attributable to higher soil temperatures in the darker containers caused by more absorbed solar radiation. Incidence of Fusarium root rot has been shown to be much higher in warm environments (4). This observation should be investigated further.

Few new infections were observed during the damage survey and it appeared that the disease had reached its maximum extent. Uninfected seedlings had grown beyond the period of greatest susceptibility to Fusarium root disease. The disease may prove to be a problem in transplanted seedlings. In a California study *F. oxysporum* did not survive on infected seedlings when transported to the field (5); however, four southern pines suffered up to 40 percent loss within four weeks after outplanting because of residual Fusarium infections (6).

The economic impact of Fusarium root disease will surpass $750 using a unit value of $.40 per seedling as furnished by the nurseryman. This is probably a conservative assessment because stunted seedlings that fail to reach merchantable grade will increase this loss as will the labor costs resulting from the hand sorting of dead and substandard seedlings from those that are merchantable. Losses after transplanting could also prove to be significant.

DISEASE CONTROL ALTERNATIVES

To reduce the possiblity of transmitting Fusarium root disease to the field, all seedlings from the infected seed lots should be checked. Stunted or chlorotic seedlings should be culled out and destroyed before shipping.

Fusarium root disease has probably run its course in this crop of tree seedlings so any control measures would be inconsequential at this time. Seedlings that have survived are probably resistant to the disease and have grown beyond the period of maximum susceptibility. Losses can be reduced in future crops, however, through utilization of one or more of the following preventative measures.

1. Application of a fungicide drench after sowing

Several fungicidal chemicals have proven effective in reducing seedling losses to Fusarium root disease. A combination of Truban and Benlate was used for control of several pathogens of container seedlings (6). Captan soil treatments were found to be effective against Fusarium root disease of Douglas-fir seedlings when applied 20 and 40 days after sowing (7). It should be noted that all such fungicidal treatments are preventative rather than curative in effect; they serve to retard disease development during the period of maximum susceptibility but cannot cure a seedling once it is infected.

2. Select seedling containers that will provide an unfavorable environment for pathogenic fungi

Disease losses can be reduced by choosing potting mixes that provide adequate drainage and good soil aeration. Coarse grade vermiculite in a 1:1 mix with *Sphagnum* peat will provide a well-drained acid environment that is not conducive to disease development.

Seedling containers should be designed to provide good drainage; the revised styroblock used at the Colorado State Forest Service greenhouse is well constructed in this respect. Use of tar paper pots should be discouraged until additional work is done on their relationship to disease incidence.

3. Sanitation of greenhouse facilities will reduce fungal inoculum levels

Greenhouse floors and benches should be cleaned and sterilized between rotations to remove plant material that can serve as inoculum sources. All plant residue should be swept up and the entire area sterilized with a dilute Chlorox solution (1:10).

An effort should be made to eliminate plant residue accumulation on and around greenhouse benches during each rotation. Weeding and thinning operations should be conducted so that all plant material is collected and removed from the vicinity.

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